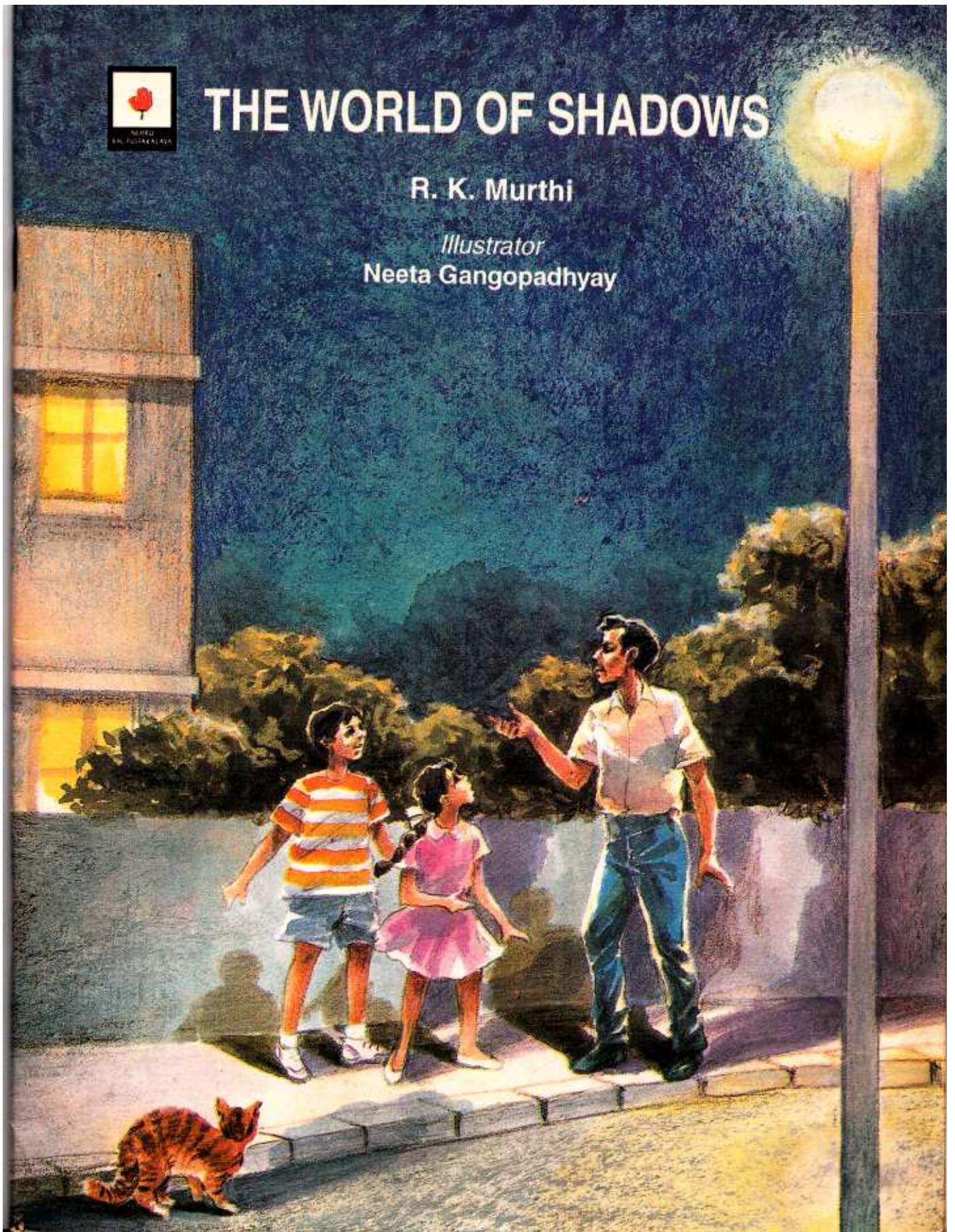


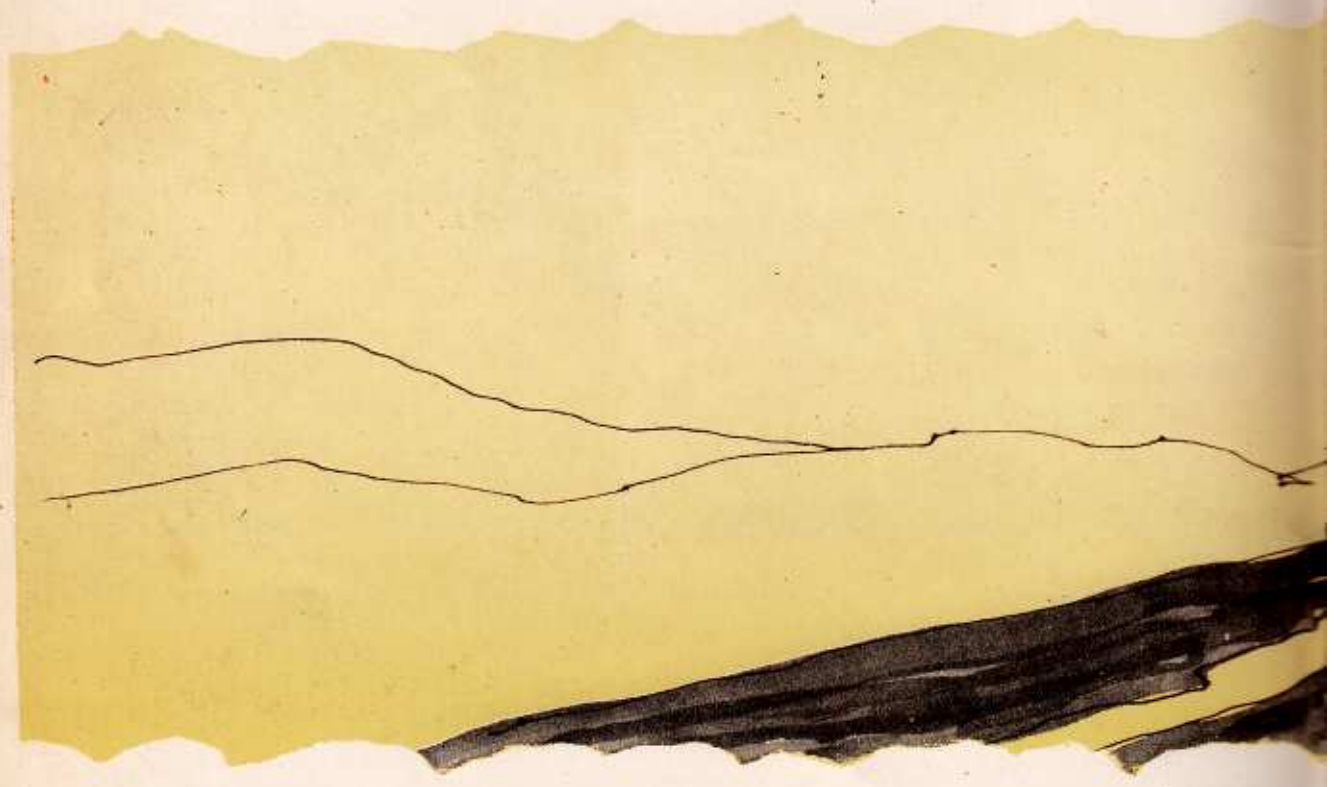


THE WORLD OF SHADOWS

R. K. Murthi

Illustrator
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"See who has come?" Mamma's call reaches us across the hall, where Shalu and I are playing a game of carroms. We drop the coins on the board and run, as fast as our feet could carry us, to the drawing room. Our eyes open wide when we spot Uncle Hari. He is mother's youngest brother, just about a dozen years older than me. That makes him close to us. So we are happy to see him.



"How are you, Ranga? And, how is my cute little niece, Shalu?" Uncle hugs us warmly.

"How do you find your job?" Mamma asks.

"Very enjoyable. You know, Sarada, I always wanted to teach. I got what I wanted. Now I teach Physics at the University. I lead young students to knowledge. Knowledge is power. Knowledge is for sharing," Uncle mumbles.

"What knowledge will you share with us?" I butt in.

"What do you want to know? History? Once Mamma and I had a fight. I pulled her by the pleated hair and she screamed. Your grandfather entered the scene and gave me a tight cuff on the ear," Uncle jokes.

"You are fun to be with," Shalu bares all her teeth, with gaps in between, because she is nine and the last of her teeth are getting replaced.

"I see a shadow of a gap," Uncle teases her.

"Time will bridge the gap," Shalu repeats what Mamma had told her when she lost her first milk tooth.

"Shall I fetch you a cup of coffee?" Mamma walks back.

"You talked of the shadow of a gap. Do you know that shadows live in a fun world?" Uncle peers at us.

"Fun world? Are you serious?" Shalu snaps.

"Yes," Uncle pauses, on sighting Mamma come with a cup of steaming hot coffee and a plate of biscuits.

We share the biscuits. Uncle drinks the coffee, places the cup back, in the tray, gets up and tells Mamma, "I will take the children out for a stroll in the park, take them on a quick trip through the world of shadows,"

Mamma looks puzzled. She pouts her lips and says, "I don't mind so long it is not a trip through the underworld?"

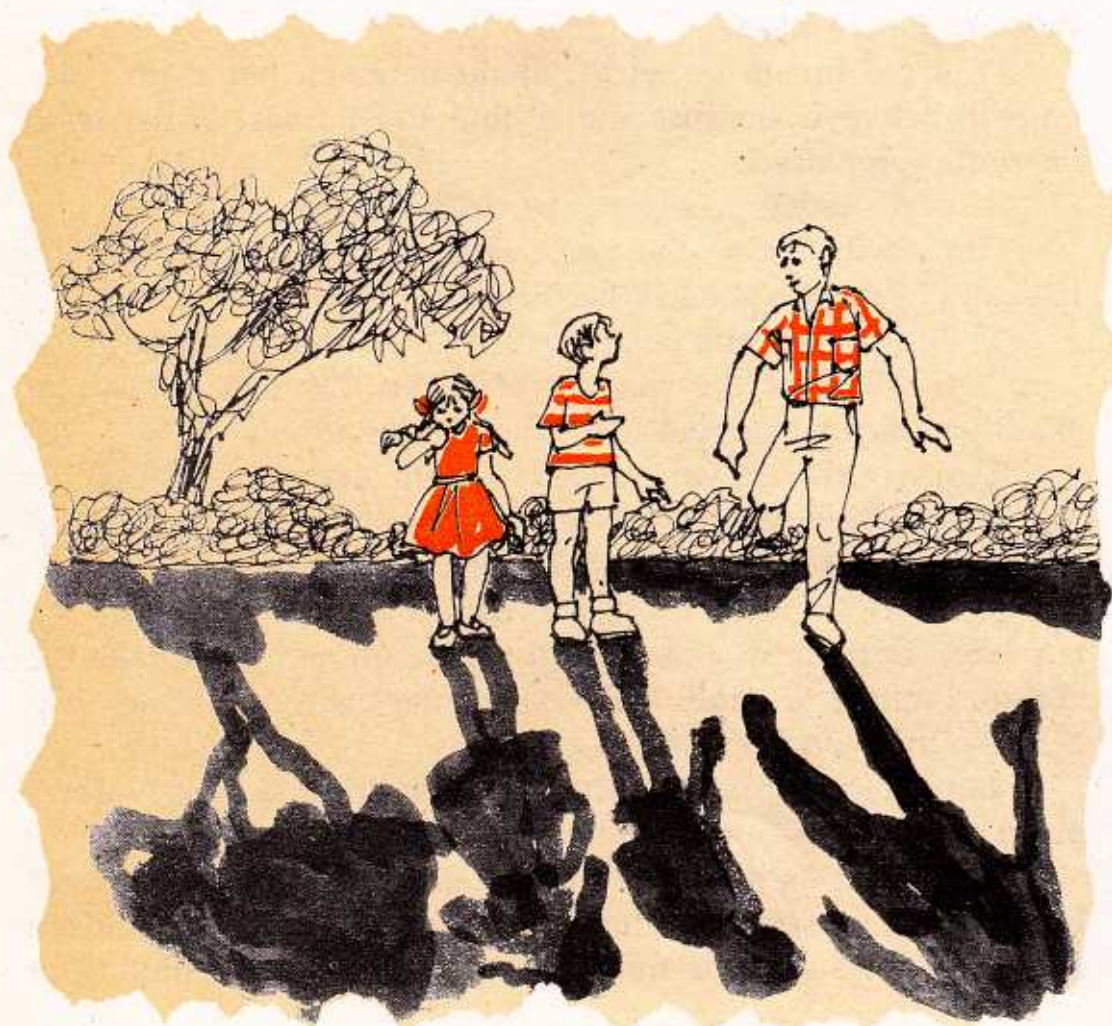
"You mean the world of thieves, gangsters, drug peddlers? I am the last person to go there. I love life. I plan to tell children about shadows and the fun they can have in the company of

shadows," Uncle lulls Mamma's fears.

"Come back before one. Ranga's father would be back by then. He wants lunch exactly at one. Heavens may fall, but he won't wait...." Mamma nods,

"Heard the quotation, 'They also serve who stand and wait?'" Uncle drops a quotable quote, smiles at Mamma and walks off with Shalu and me on trail.

We come on to the pavement, head toward the park. After covering some distance, Uncle stops and points to our shadows which lie in front of us.



Behaviour patterns of Shadows

"This is my shadow. Its feet always sticks to my feet. But look at its waist, its arms and neck and head. They are far out on the ground," he says.

"It is so with my shadow too," Shalu is delighted.

"Same here," I point out.

"Watch me," says Uncle. He lifts his right leg. The shadow moves its right leg. The leg forms a crooked shadow. The foot stands away. Then, Uncle brings his foot down. The shadow is equally quick. Its foot is now right there, touching his foot.

Shalu repeats the show with her left foot. I bounce up, take to the air, with my legs folded, fly in space for just a second, while my shadow has both its legs away from me. Yet, the moment I land, the legs are back there, touching my feet.

"Want to put the shadow behind you?" Uncle asks.

"How can I do that?" I want to know.

"Easy, my boy. Let us turn around and face the sun," says Uncle.

We do that. The shadows are not visible. "They are behind us," Uncle turns his neck ever so slightly. Shalu and I do that. And we spot the shadows, right behind us, turning their necks.

"They are copycats," Shalu drops a comment.

Shadows Back Away from the Source of Light

"I have never seen a copycat. Is the copycat also a shadowy figure?" Uncle jokes. Then he asks us, "Now, tell me. Have you noticed a fact? When we face the sun, the shadows lie at our backs. When we have our backs to the sun, the shadows are in front of us. Can you guess the reason?" Uncle asks.

"For that we will have to put our thinking caps on," I remember a phrase which I had once heard Uncle use. He had then explained, "That is just an idiom. It stands for thinking on one's own."

"Do that," Uncle smiles.

Shalu bites her lower lip. I scratch my head. Each of us is keen to be the first to get the right answer.

"I know," says Shalu, her face brightening up. "The shadow runs away from the sun. The shadow is afraid of the sun."

"Silly," I grunt.

"Shalu is silly when she says the shadow is afraid of the sun. But she is right when she says it runs away from the sun," Uncle buys peace between me and Shalu. Then he adds, "Remember that there is no shadow without light. Shadow and light go hand in hand. Look at the shadows in front of us. They are there because of the sun. At night, if it is pitch dark, all around, no shadow keeps us company."

We move forward, near the entrance to the park. A wall encircles the park. Our shadows now lie partly on the ground,



partly on the wall. The shadows have their lower limbs on the ground. The rest of the shadows lie on the wall. Uncle stops, draws our attention to the queer shapes the shadows have formed.

"The shadows now lie in two planes," Uncle says.

"That is plain enough," I pun with the word 'plane'.

"We can break the shadows into different planes," says Uncle, while leading us to a spot where a hedge stands close to the wall. The hedge is half the height of the wall. Uncle says, "Look at the shadows." We examine the shadows. The lower limbs of the shadows are on the ground. The torsos throw shadows on the hedge. The necks and the heads of the shadows are there on the wall. The shadows look twisted, odd.

Shadows and Mirror Images

I raise my thumb, put it on the nose and make faces. My shadow also makes a similar gesture. That reminds me of the mirror. "Is the shadow mere mirror image?" I want to know.

"The answer is Yes and No," Uncle laughs.

"How can one answer a question with an Yes and No at the same time?" I ask.

"Well, in some cases, it is possible. This is one such case. I will show you why. Raise your right hand. Watch the shadow. What happens?"

"It raises its right hand," I say.

"Remember what happens when you stand before a mirror. You raise your right hand. And, then,....." Uncle expects us to complete the sentence.

"And then....." I repeat.

"And then the reflection raises its left hand," Shalu comes up with the answer.

"You said it." Uncle pats her, in appreciation, while I groan.

"That is the difference. The shadow does not change right



into left; or left into right. That is where the shadow is better than the mirror image," Uncle leads us to the park. We take the footpath that goes round the park. The shadows shift places. Now they are directly in front of us, Then they shuffle to one side or the other; or goes out of sight, slide behind us and expect us to turn our heads if we want to see them. The shadows are ever on the move. They refuse to stay put.

Shifty Shadows

Uncle points out each shift. Then he asks me, "Can you tell me why that happens?"

Shalu and I start speaking together. Uncle puts his index

finger on his lips and silences us. Then he says, "So both of you know the answer. Good. Shalu, you whisper it in my ears. Then Ranga will speak it out loudly. Thus I can check whether both of you know the right answer. Or one or other of you or both of you could be wrong," Uncle acts like the quiz master.

Shalu gets close to Uncle. She speaks into his ears, while I stand a little distance away, as if it does not matter. Uncle nods his head, smiles and says, "Shalu has got it right. What about you? Speak out, boy."

I tell him, "The shadow has no life of its own. You told us that where there is no light, there is no shadow either. Here the sun is the source of light. The footpath goes round the park. We take turns to go round. So the direction at which the sun's rays catch us changes. The shadows too shift. The angle at which the rays of the sun hit us decides where the shadow lies. The shadow lies away from the source of light. Am I right?" I want to confirm.

"You are right. Shalu too told me the same thing. See, thinking caps have their uses," Uncle jokes.

We see patches of light and shade on the ground. Uncle points out the patches to us and says, "The shade that a tree casts is nothing but its shadow. It shifts according to where the sun is. The shade always lies away from the sun."

"And forms lovely paintings of light and shade," I observe.

"That is true. Some rays are clever. They do not run into leaves or branches or trunks. They reach the ground, without bumping into any obstacles. They paint the scene with bright light. Some rays bump into leaves or branches or trunks. They struggle to get free.

"Every obstacle demands its share of light. Some make small demands. The leaf, for example, keeps back only a very small amount of light. So the shadow it casts is brighter. The branch of a tree takes more light unto itself. So its shadow is less bright. The trunk claims all of the light. The light gets imprisoned. No



light passes through. So the shade is completely dark," Uncle gives us the details.

Measuring Heights with the Help of Shadows

Uncle lifts his head up, as we near a palm tree. It is straight and tall. Its shadow is also straight and long. "How tall is this palm tree?" Uncle comes up with a question.

"10 metres," I guess.

"No. It is only 8 metres," Shalu thinks my guess wrong.

"I want the exact height," Uncle growls.

"How can we do that? We don't have a measuring tape with us?" I point out.

"Here, take it," Uncle pulls out a measuring tape from his pocket.

"You did not give me time to point out another problem. How can I get to the top of the palm tree? Put me there and I will measure the height by sliding the tape along the trunk. Then you can read out the height. But, promise me, once you find out the height of the tree, you will bring me back, safe, to the ground," I roll on.

"No monkey tricks, please," Shalu pulls my leg.

"A monkey's sister can't be anything but...." I leave the sentence half-said.

"We are all descendants of monkeys. So says Charles Darwin, in his *Descent of Man*," Uncle holds us apart, lest we go at each other's throat. Then he adds, "Listen, my boy. You don't have to go up the palm tree to measure its height. We can do it, while we remain here, on the ground," Uncle replies.

"Impossible," Shalu shouts.

"Impossible is often the untried," Uncle bends, picks up a stick, slightly more than a metre long. He puts the tape at one end of the stick. He notches a mark one metre from the end. A couple of centimetres of the stick stand beyond the mark.

Uncle comes down on his knees, reaches for a sharp stone and digs a hole with its help. The stick goes into the hole. The mark on the stick is in line with the ground.

Shalu and I watch, with fascination. We guess there is a purpose behind Uncle's moves. But what it is, we have no idea.

Uncle shows us the shadow of the stick. "Measure the shadow," Uncle tells me. I do that. It is 50 cm long. "Make a



note of that. The stick is one metre long. It casts a shadow that is 50 cm long. The shadow is exactly half the height of the stick. Right?" Uncle says. We nod our heads.

Uncle now directs us, "Go and measure the length of the shadow of the palm tree."

I walk over to the foot of the palm tree. Shalu is right behind. I tell her to hold the tape's end at the foot of the tree. I retreat. The tape unrolls out of the steel case. I reach the tip of the shadow and then take the reading from the tape. "The shadow

is 9 metres long," I tell Uncle.

"Well, give me the exact height of the palm," Uncle says.

Shalu and I look confused. Then Uncle says, "Exercise your grey cells." We are puzzled. Where are the grey cells? How does one put them through the drill. Uncle notices the confusion and laughs, "The brain is often referred to as the grey cells."

Shalu and I put our heads together. It is said that two heads are better than one. Then we see the answer. We tell uncle, "The palm tree is exactly 18 metres tall."

"You got it right. Next time, when you go on a picnic, around a tower or a Minar, carry a measuring tape with you. Go only on a bright sunny day. Then you can measure the height of the tall structure, exactly. That is a simple task," Uncle gives us a tip.

Earth Is Round

"So the shadow can do only simple tasks," I stress the word ONLY.

"There you go wrong. The shadow does more complicated tasks too," Uncle grins.

"Who makes them work?" Shalu asks

"Anyone who is observant. Look at the earth. Does it not look flat?" Uncle pauses.

"Yes. Yet we know that it is round," Shalu is quick to have her say.

"Don't forget that it is a sphere pressed down a bit at the Poles," I put her down with that added information.

"Well, for ages, man believed that the earth was flat. Then came Aristotle. He was a student of nature and spent many hours, watching the sky at night. The stars winked at him, as they do today, at us, if only we care to look at them. He saw the moon wax and wane; and wax again. There was a pattern in its growth from nothingness to fullness; and hence to nothingness.

On new moon day, the moon remained invisible. Next day, there was a thin sickle moon. The day after, the sickle had one more layer of light. This continued for fifteen days, when the moon was fully lit. The next day, the moon had a curved slice chipped off. Each successive day, one more slice was ripped out. Fourteen days later came yet another new moon. Or, *no moon*, if you may say so. For it was not visible.

"We know. The moon goes round the earth. Its path is clearly defined. It rolls around, continuously. After the new moon, each night, we see a larger area of the moon lit by sunlight than on the night before. Then comes the full moon night. The moon looks like a golden cake. Next night, the moon has a curved slice chipped off. Every night, we see a lesser area of its sunlit surface. Finally, on new moon night, we see nothing of the moon," says Shalu.



"Aristotle was out on a full moon night. He could not believe his eyes. The moon seemed chipped. A slice of the moon was in the shadows. The edge of the shadow, which lay with the moon, looked curved. The shadow crept on, till the moon became completely dark. Then a slice of a moon reappeared. More of the moon was now lit up. Soon the moon regained its full brightness. Aristotle had witnessed an eclipse of the moon.

"What cast the shadow? Why did the slices of the shadow always have curved edges? Aristotle asked himself.

"He did not get the answers, immediately. But he did not give up. He tested various possible answers. Then he hit the right key. He guessed that the shadow was cast by the earth. Only a curved surface cast curved shadows. So the earth could not be flat, as people believed. It must be round. Shadows helped Aristotle see the truth," Uncle beams a big smile.

Measuring the Earth's Circumference

"The shadow has led us to many facts of nature. For example, we measured the palm tree's height with the help of its shadow. About 2400 years back, the Greek mathematician Eratosthenes measured the circumference of the earth, with the help of shadows. That, mind you, was not a simple task," Uncle waits for us to react.

"Did he use sticks, as we did," I want to know.

"Of course, he did. But he faced more problems. He could not conduct his study on any day. He had to find the right time. He had to decide the exact date when the shadows would work well," Uncle clears his throat.

"Tell us about this man, Erato..." Shalu finds it difficult to repeat the name correctly.

"Eratosthenes..." Uncle prods her, and then continues, "He was born in Alexandria. He travelled widely. For some time, he stayed at the city of Syene, which is about 800 km from his

home. His friends told him of a deep well, in one part of the city. One could see the bottom of the well only at noon on June 21. On other days, shadows darkened the bottom and made it invisible. That roused the curiosity of Eratosthenes. He searched for the reason. It did not come to him easily. But he did not give up. He turned the problem around. Why did not the shadow fall into the well at noon on June 21? Then he remembered. At noon, on 21 June, no tower or tree cast a shadow at Syene. The sun, he guessed, was directly above the town, on that day.

"He also remembered his days in Alexandria. There, on June 21, at noon, the trees still cast shadows. The shadows were short, but they were there. He remembered that the earth is a sphere. So, when the sun cast its light directly over Syene, Alexandria received it at an angle.

"Could he find the angle at which the rays of the sun hit Alexandria? That was not difficult. He returned to Alexandria by mid June of next year. On June 21, he walked out to a vast open meadow, carrying with him two long rods. He planted the shorter of the rods in the ground. He watched the shadow. Exactly at noon, he held the longer rod. He placed one end against the far end of the shadow on the ground. He rested the rod on the head of the rod driven into the ground. Now he had a right-angled triangle. He measured the angle formed by the two rods. It was 7.2 degrees.

"He sat down to calculate the circumference of the earth. 'The earth', he told himself, 'is a sphere. Alexandria and Syene are 800 km from each other. The sun's rays come to Syene, straight down. They come at an angle of 7.2 degrees to Alexandria. A sphere has 360 degrees in all. 7.2 is one-fiftieth of 360.

"Eratosthenes multiplied 800 by 50. He estimated that the earth's circumference is 40,000 km. See, he measured the earth's circumference with the help of shadows. He did not have the

fine tools scientists now have. Yet his calculation is off the mark by just about 100 km. Give him a big hand," Uncle completes the story.

Reading Time with the Help of Shadows

"Imagine an age when man could read time only with the help of shadows that nature cast. Then someone developed an instrument to read time with the help of shadows. This instrument is known as the sundial. The name is apt. For the sundial needs the sun to cast shadows. It works only during the day. That too when the day is bright and sunny. Not otherwise. So you can't seek time from the sundial at night; or on a cloudy or misty or snowy day. Yet, when it works, it gives time fairly accurately. Believe it or not, till about the middle of the 18th century, the sundial was the most popular instrument to read the time. Then came clocks and watches, driving the sundial out of employment," Uncle gives a background of the sun dial.

"The sundial must be happy. It doesn't have to work any more," Shalu spots the brighter side of it.



"Work is worship, Shalu. Sundial is no longer in use. So we don't care for it. It has fallen into bad days. You will know about the tragedy that has fallen the sundial when you see one of them. The sundial once had a bright brass plate, polished, showing the markings very clearly. Now the markings are almost invisible. The short length of slanted blade too looks rusty. The platform on which it is mounted is cracked. The walls which support the platform are almost ready to collapse. Nobody maintains the sundial now. It is living in the shadow world of neglect. All because we don't need the sundial any longer to tell us time," Uncle tells the sundial's tale of woe.

"And there is no chance of better times to come, as far as the sundial is concerned," I note.

"You said it. Well, let me explain how the sundial works. It has a raised metal plate. Its base is fixed at the centre of a metal sheet, which has time marked on it. The top edge of the metal plate tapers off. Its sharp end points due north. The raised metal plate casts its shadow on the plate with the markings. The reading which coincides with the shadow gives the time," Uncle wonders whether we have followed him clearly.

"But does not the earth go round the sun? Because the earth goes round the sun, we get the seasons. So the time the sun rises or sets never remains constant. How then can the sundial give the right time?" I ask.

"Well, the metal plate carries a table of correction factors. The shadow gives the approximate time. By using the correction factor, one works out the exact time," Uncle pauses. Then he adds, "You can make a sundial, at home. The method is quite simple. Place a table in the badminton court which lies at the back of your house. Get hold of a thick cardboard. Draw a circle of 15cm radius on it. Divide one of the semicircles into 12 equal parts. Mark the parts with readings moving from 6 to 12 and then 1 to 6. Fix the card on the table, with tacking pins.



"Get hold of a metallic lid; or a tin sheet; or any other firm material. Shape it into a right-angled triangle. Fix the base along the cardboard. Move it till the vertex formed by the base and the hypotenuse... the hypotenuse is the longest side of a right-angled triangle... lies at the centre of the cardboard. Point the top edge due north. If you want to be very exact, use a compass. The cutout casts its shadow. It is a thin line. It runs over one of the marks on the cardboard. The mark over which the shadow lies gives the time. Check with your watch. Note the difference, if any. That will give the correction factor too. Remember, the correction factor will change according to the date. But once you know the correction factor, the sundial gives right time," Uncle has his say.

"Splendid," Shalu claps her hands.

"Splendid?" I break the word Splendid, deliberately, and then ask Shalu, "Who is Splendid, dear? And what did he do?"

"Splendid, unlike my brother, is no fool," Shalu comes back with a snipe.

"You called me a fool? Then who are you?" I grind my teeth.

"The shadow of a fool," Shalu turns to Uncle and says, "Sometime I go after him; at other times I go behind him. But I am always with him. Am I not his shadow then?" Shalu can argue well.

Fixing the Direction

"I wish I can send you to the north pole," I grunt.

"How can you find the north pole. You have no compass," Shalu jeers.

"Ah, shadows can help us fix the north pole if you have a watch," Uncle breaks in.

"How can shadows do that?" I can't believe my ears.

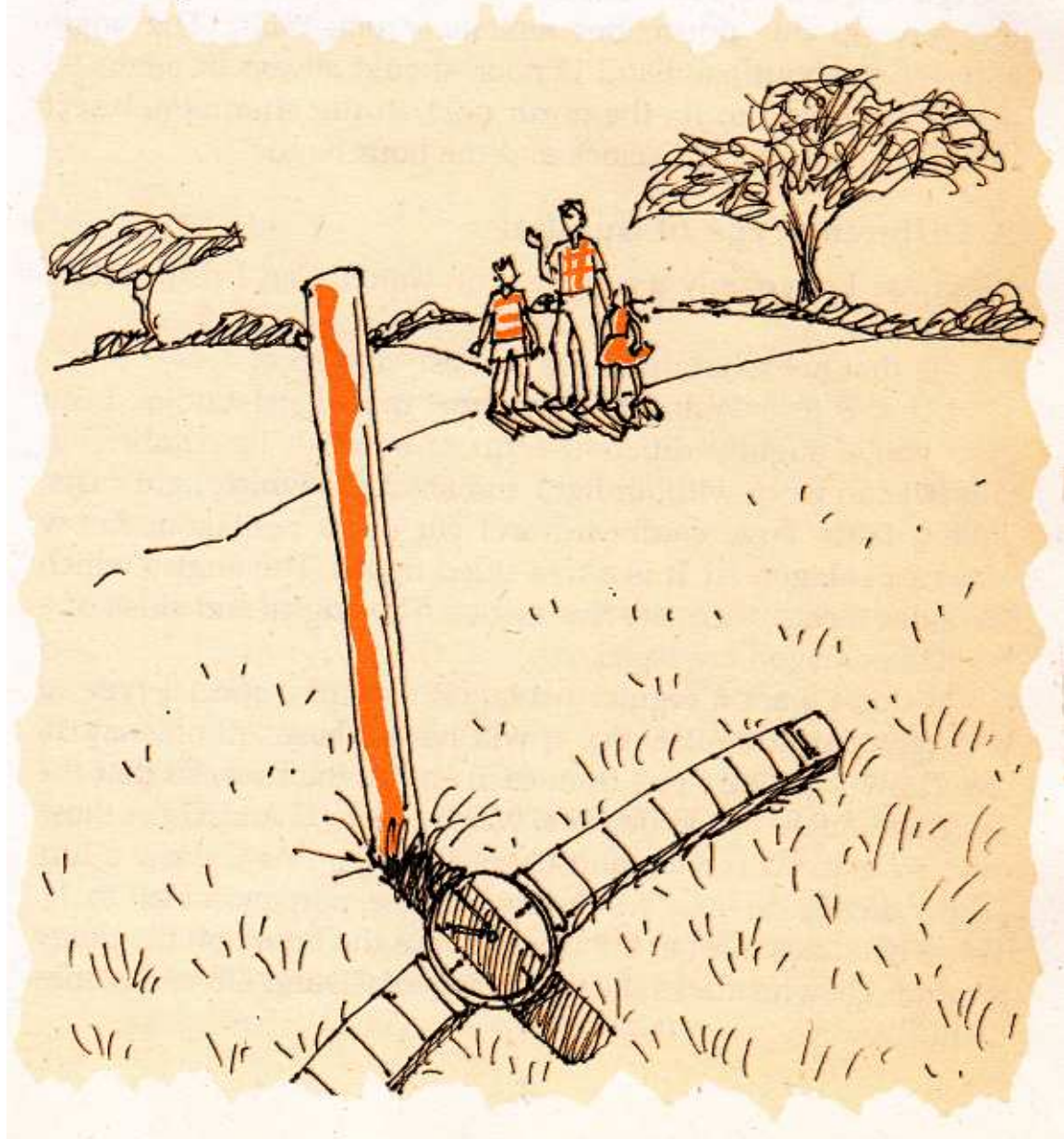
"Let me show you how to fix due north," says Uncle. He leads us to the expansive grassy meadows, in the centre of the park. It is lit by bright sunlight.

"Fetch me a stick. Not a long one, please. It should be straight," Uncle tells me.

I run over, check for sticks which are straight. I have a hard time. Most sticks are crooked. "Crooked they come, crooked they go," I mumble, throwing them away. The search for a straight stick continues. "Is this search like the quest for the needle in the haystack?" I wonder.

I put that thought aside. Finally, after a long search, I find what I want. It is a stick, which is straight... ramrod straight, if I may add... and is about half a metre in length. I run back to Uncle, waving the stick. He examines the stick and says, "That would do."

He makes us sit by his side. We watch while he fixes the stick firmly in the ground. It now stands, perpendicular to the ground, and casts a shadow. Uncle takes off his watch and slides it along the shadow. Shalu and I watch with wide open eyes. It takes Uncle sometime to adjust the watch so that the hour hand points toward the sun. He also ensures that the shadow of the stick goes over the hour hand.



Then he invites us to take a look. Shalu and I peer at the set up. Then I say, "The hour hand points toward the sun. The shadow of the stick goes over the hour hand. The hour hand and the shadow are in line with the sun. The time is 11 O'clock."

"Good. Now I can tell you where due north is. It is the line that bisects the angle between the hour hand and 12 O'clock. In this case, it is the line that connects the centre of the watch with the reading 1130. Stretch this line away from the sun. It runs all the way up due north. But remember one thing. The angle between the hour hand and 12 noon should always be acute. So if you are trying to fix the north pole, in the afternoon, bisect the angle between 12 O'clock and the hour hand."

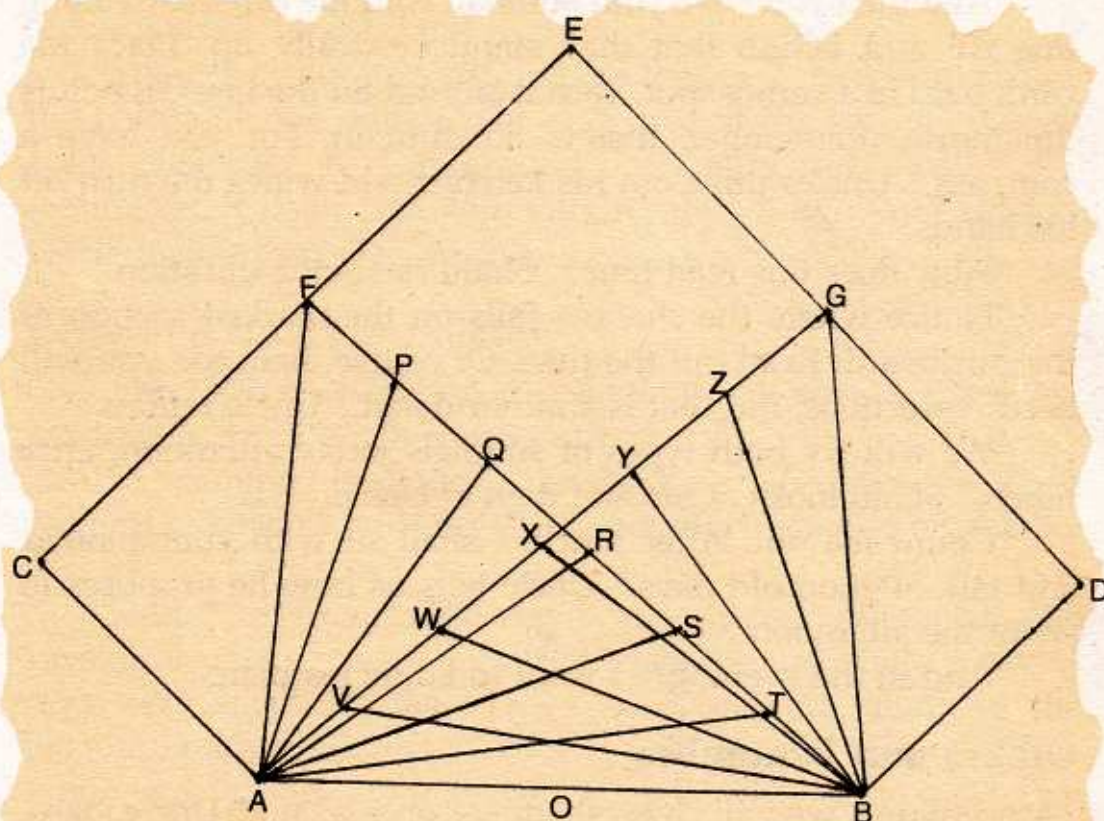
A Different Type of Sundial

"Suppose I have only a compass, no watch. Can I read time?" Shalu asks.

"Is that not what the sundial does?" I snap at her.

"That is true. Well, I told you how to make a sundial. I can give you a slightly different form of sundial. Remember, no sundial can work without light and shadows which light casts. Take a fairly large cardboard and cut out a pentagon. Know what a pentagon is? It is a five-sided figure. The angles which the sides form... there are five angles. The angles and sides of a regular pentagon are equal.

"I don't want a regular pentagon. I want a special type of pentagon. An irregular one. It will have a base AB of... say 16 cm. Draw two lines, one from each end of the base, so that the inscribed angle is 135 degrees. Mark points C and D on these lines so that AC is 8 cm and BD is also 8 cm. At C draw a line perpendicular to AC. At D draw a line perpendicular to D. These two lines meet at E." Uncle draws the figure on the dusty ground. Then he marks the mid points of CE and DE and names them F and G.



He says, "Divide FAB into six equal angles by marking lines between AF and AB... AP, AQ, AR, AS and AT.... AF stands for 12 noon; AP for 1 p.m.; AQ for 2 p.m.; AR for 3 p.m.; AS for 4 p.m.; AT for 5 p.m.; and AB for 6 p.m. Similarly draw lines between BG and BA. These lines will mark the morning hours, from 6 a.m. which will be represented by AB and 12 noon by BG."

Uncle marks the midpoint of AB, calls it O. Then he says, "Got all the details. Draw this figure on the cardboard. Cut along the lines," he adds.

"And then?" We are getting impatient.

"And then you have your sundial. Fold the cardboard along line AF and BG so that they stand vertically up. Place the cardboard in a sunny spot. Turn it around till the line OE points due north. Remember, that is no difficult. For you have a compass," Uncle pulls out his kerchief and wipes the dust off his hands.

"How does this read time?" Shalu raises the question.

"Notice where the shadow falls on the marked section of the cardboard. Read out the time. Of course, here too you will need corrections. But that is a minor detail," Uncle replies.

"We will try both types of sundials today afternoon, after lunch," Shalu looks at me and then at Uncle.

"Count me out. After lunch, I shall sit with your mother and talk of good old days," Uncle tells us how he proposes to spent the afternoon.

"And in the evening?" I want to know his plan.

Umbra and Penumbra

"After dinner, we will chase shadows, once again," Uncle jokes.

"Ah, I think I must introduce you to two words, *umbra* and *penumbra*."

"Big words! Do big words make one a big mouth?" Shalu pops up with a question.

"Shut up, you big mouth. Listen to Uncle. He still has not explained the two words," I silence her.

"Look at any shadow. It is not uniformly dark. The shadow which lies very close to the object is dark. This is the core of the shadow and is known as the *umbra* region. The shadow around the *umbra* is not so dark. It is called the *penumbra* region. These terms are widely used in reference to eclipses. The dark inner core that one notices during an eclipse is the *umbra*. Around it is the *penumbra*. One may look upon the *penumbra* as the halo of the *umbra*," uncle pauses.

"That makes the *umbra* a god? If not a god, at least a saint," Shalu is quick to point out.

"You are clever, my girl. I agree that gods and saints share the halo with the *umbra*. The core area of the shadow has an edge. This edge goes all around the *umbra* and is called the *penumbra*. It is an area with varying mix of light and shade," Uncle makes the meaning clear.

Long and Short of Shadow

Suddenly his eyes fall on his shadow. He scowls. "See my shadow. Is it not much shorter now?"

We examine his shadow. We check our shadows too. Then we nod our heads and say, "They are much smaller now. Why is it so?"

"Simple, my dear. The sun is now almost overhead. The rays of the sun come directly. The angle the sun's light forms is now very small. So the shadow also becomes small. In the evening, once again, the sun's rays will come at an angle. This angle will gradually increase. That is why when evenings approach, we say, 'The shadows are lengthening.' The shadow becomes shorter between sunrise and noon. It grows longer between noon and sunset," Uncle explains yet another fact about shadows.

He checks the watch and says, "We must get back, now. It is already 12.30. Your mother has fixed 1 p.m. as the time for lunch. Your Papa wants it on the dot. I don't want to run into his bad books," Uncle jokes.

"So Papa keeps a bad book too? Is there not a name for bad books?" I struggle to find the word, but fail.

"I was only using an idiom. Run into his bad books means: I don't want to displease him. I don't want to keep your Papa waiting. I want to be a perfect guest, one who keeps the time the host sets," Uncle explains.

We walk back home. "I am hungry," groans Shalu.
"Say, we are hungry," I amend her groan.

An Ounce of Practice

Shalu and I spend the entire afternoon dating shadows. We take about an hour to make the sundials. Finally we have them, one of each kind. We run to the open area, at the back of the house, place the sundials, setting the direction due north, with the help of the compass.

We take several readings. We take readings from both sundials and feel pleased. For they show almost the same time. That is the best we can expect. Have you read time off any two clocks or watches? Even the best of them differ by a minute or two.



Shalu and I have a wonderful time, playing with the sundials. Time flies. The shadows begin to lengthen. We know why. Dusk is falling fast. We gather the sundials, cart them back to our room and run to the drawing room. Around the central table, we find Uncle and Papa. On the table is a plate piled with pastries. Uncle and Papa are sipping hot coffee, while sharing jokes and laughing heartily.

"What is the big joke?" I butt in.

"This one is not for you," Papa laughs.

"Is it adult rated?" I remember the pun in time.

"Right. Come on, kids! Don't pastries appeal to you? When we were children..." Uncle starts narrating tales of his childhood days.

This talkathon.... you know what it is. You know what a marathon is. A long talk session, I may therefore say, is a talkathon... spills over to dinner time. Not that Uncle monopolises the talk. Papa and Mamma also join in. Shalu and I too find opportunities to have our say. Is talkathon, then, the right word? Should it read Relayathon? Don't look for talkathon and relayathon in the dictionary. They are new words, yet to find their places in the dictionary. It has always been so. Words are coined. Or, if you prefer, words are minted. They get into circulation. More and more people use new words. Soon, the scholars take note of the words. They tell the right people, the ones who have the authority to open the doors of the dictionary to new words. There is a name for them. Let me check with Uncle. Ah! He says the name is lexicographers. Once they give the nod, the words enter the dictionary. Both talkathon and relayathon, I think, will enter the dictionary. They will, if all of us support the move.

After dinner, Uncle tells Papa, "I think we should take a stroll."

"Leave me out. I am tired," Papa mumbles.



Multiple Shadows

"Want to come with me? We can chase shadows, once again," Uncle turns to us.

"Let us go," Shalu and I shout together.

We walk out of the gate and move along the pavement. The street lights keep darkness at bay. Between street lights, there are varying shades of light and darkness. We stand right beside a street light. Uncle shows us our shadows. They are right under our feet. Down at our heels, if one may say so. They are very small blobs of darkness.

We take a couple of steps forward, in the direction of the next street light. Our shadows lengthen in front of us. They are a little less dark. Uncle takes us forward, till we reach almost

mid point between the two lamp posts. We stop and peer at the shadows which lie in front of us. Then Uncle says, "There are shadows behind us too." We turn our necks, catch the shadows at our rear. The shadows in front and at the back seem to be of almost equal lengths.

"Come. Let us walk closer to the next lamp post," Uncle hurries us along. The shadows in front of us become less clear. They stretch farther and farther, almost become undefined and vague. The shadows, on our rear are now short and well-defined. We stand under the lamp post. Our shadows, short and dark, lie at our feet.

"Now you know how you can cast two shadows, at the same time. If there are more lights around and I move across the light cast by all of them, each light will cast a shadow of me. Each shadow will lie in the direction opposite to the light that casts the shadow. Often these shadows may fall, one top of the other. They may cross each other. They may bump into each other. But, they suffer no bruises. They don't get hurt, in any way," Uncle waits for us to get that message.

Then he stands with his back to the light and makes me shift around till I am in front of him. He tells Shalu to stand in front of me. She does that. "How many shadows are there?" Uncle asks. We see just one. We are baffled... There should have been three. Yet there is only one shadow.

"Whose shadow is that?" Shalu asks.

"Mine," Uncle winks at me.

"Where have our shadows gone?" Shalu wants to know.

Shadows and Eclipses

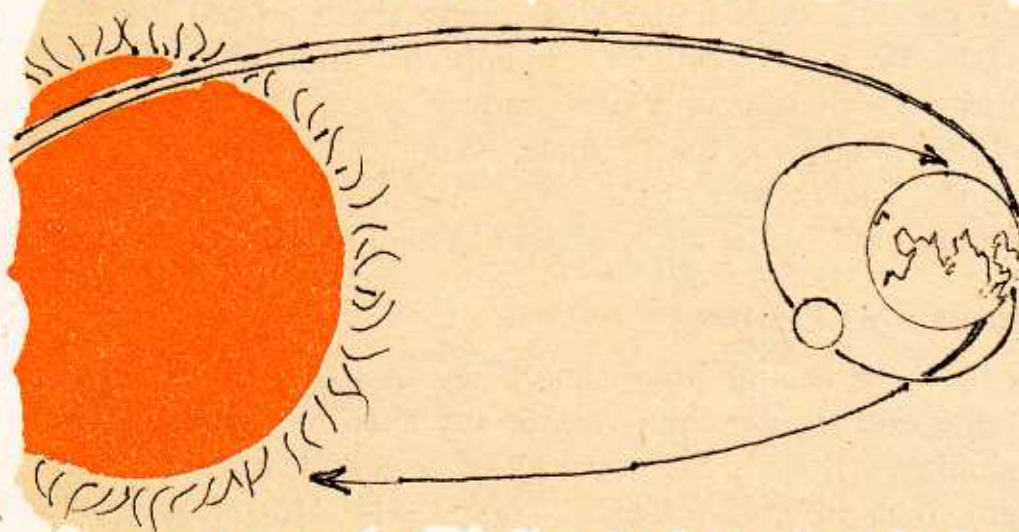
"They are there, though not visible. They are lost in my shadow. I am taller and stouter than you. So my shadow overshadows your shadows. It happens when all of us stand in a line with the light. Not otherwise. Get it. This is one form of eclipse,"

Uncle introduces a new theme.

"I remember what you told us in the morning. Aristotle watched a lunar eclipse. The sun cast the shadow of the earth. The shadow fell on the moon. The shadow's edge was a curve. Aristotle sought the reason. He found it. The earth is a sphere. So its shadow shaped a curve on the moon," I repeat the story Uncle had told us earlier in the day.

"What is an eclipse? It is nothing but a shadow that makes the moon or the sun fully or partially invisible for some time. How does this happen? For that we will have to go over some astronomical facts. We know that the sun is at the centre of our universe. The earth goes round the sun. It also goes round its axis. The moon goes round itself. The moon also goes round the earth.

"The sun remains stationary. The earth and the moon are always in motion. They move along set paths. These paths are called their orbits," Uncle stops, after noticing Shalu waving her hand.

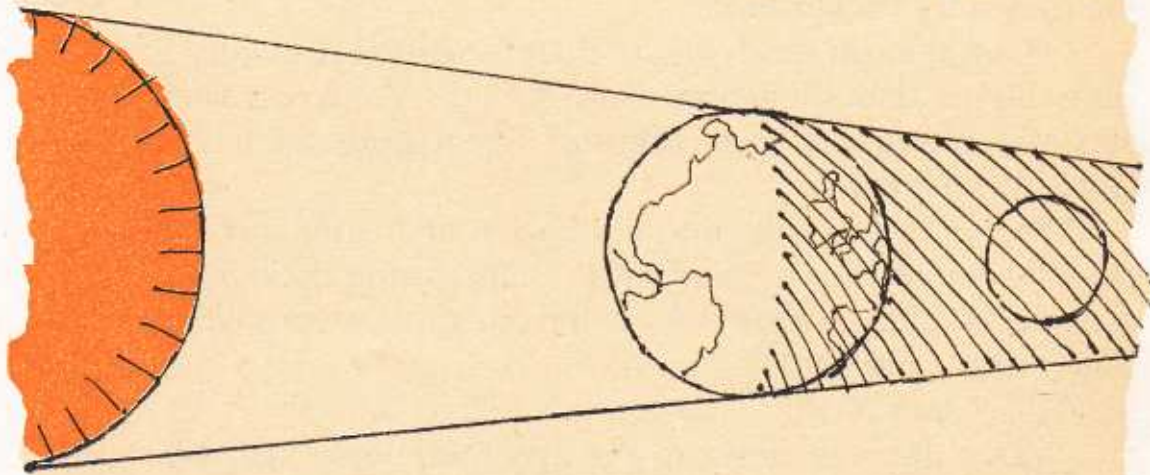


"Yet another big word. What is wrong with the word 'paths'?" Shalu snorts.

"Nothing wrong. But, astronomers use only the word orbits. Who are we to question them? Better fall in line with them," Uncle gently pulls Shalu closer and continues, "Sometimes, during their motions, the earth comes between the sun and the moon. This happens always on full moon nights. The earth casts a cone-shaped shadow. The cone stretches to nearly 1.6 million km. It lies away from the sun, the source of light.

Lunar Eclipse

"As the moon goes round the earth it is drawn into the cone-shaped shadow. One edge of the moon's rim goes in. The full moon now looks chipped on one edge. The chip is shaped as a curve. The moon moves further. More of the moon is lost in the shadow area. Sometimes, the moon slips completely into the cone-shaped shadow. For a few minutes, the moon appears dark



reddish in colour. This is known as a total eclipse of the moon. The moon moves on. So does the earth. The moon comes out, part of it appearing outside the shadow. Gradually the moon moves out of line of the sun and the earth. The eclipse. . .” Uncle explains.

“You call this lunar eclipse,” Shalu remembers the right word.

“*Lunar* means ‘of the moon’. Have you ever heard the word *lunatic*?” Uncle wants to know.

“One who is mad is a lunatic,” I have the right answer.

“People used to believe that the moon was responsible for turning people mad. Hence the word *lunatic*. There is an idiom too. A mad man or a lunatic is said to have a touch of the moon,” Uncle laughs. We laugh with him.

Solar Eclipse

“The sun and the earth join hands to cast shadow on the moon. They conspire to eclipse the moon. The moon does not forget that. It waits for revenge. It gets its chance when it finds itself between the earth and the sun. The sun becomes hidden, eclipsed. This could be partial or total. This is known as a solar eclipse and always falls on a new moon day,” Uncle gives us the necessary background.

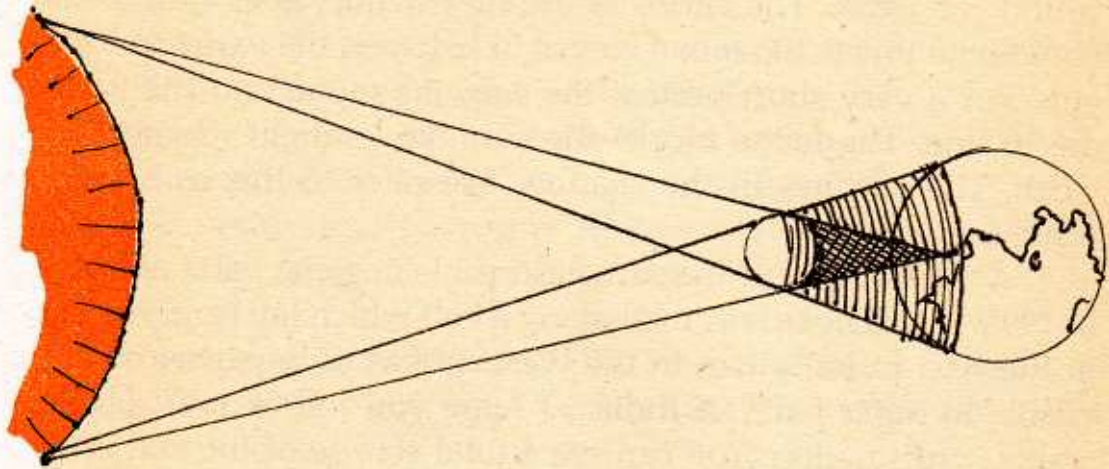
“Is not the sun much bigger than the earth? And very many times bigger than the moon? How then can the moon block the sun and produce a solar eclipse,” Shalu finds some flaw in Uncle’s explanation.

“Shalu,” Uncle digs into his pocket and pulls out a rupee coin. He hands it to her and says, “Stand facing the light. Close one eye. Hold the coin in front of the other eye, at some distance. Can you see the light?”

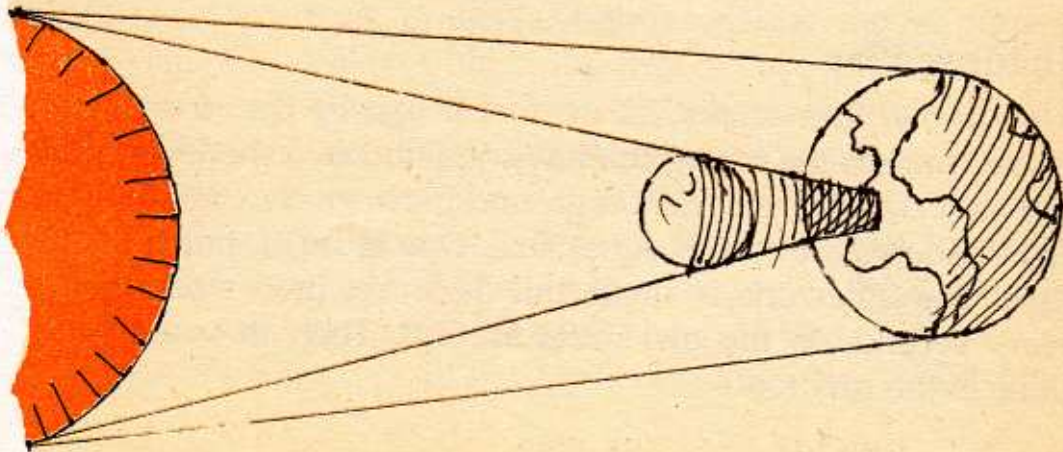
“Yes,” says Shalu.

“Move the coin closer to the eye. Still closer. Can you see the light?” he asks.

“No,” Shalu replies.



"You know how big the light is. Yet a small coin blots out the light: Why does this happen? The coin obstructs the light. It cuts out the light totally. No light from the light reaches your eye. So you don't see the light. For you it is like a total solar eclipse," Uncle grins.



"What acts as the coin, in a solar eclipse?" I ask.

"The moon. It is the natural satellite of the earth. It goes round the earth. The earth, in the meanwhile, goes round the sun. Some times, the moon comes in between the earth and the sun. For a very short period, the sun, the moon and the earth are in line. The moon blocks the sun. No sunlight reaches the earth. The sun lies in the shadow. We refer to this as a solar eclipse.

"A total eclipse of the sun was visible in some parts of India in 1995. The eclipse was total along a belt which lay from Assam in the East to Rajasthan in the West. It was only partial or not visible in other parts of India... I hope you follow me." Uncle wants confirmation. You can see a total eclipse of the sun only if you are standing in the *umbra* of the moon's shadow.

"During the eclipse, astronomers kept a close watch over the sky. The event was covered over television," Uncle reminds us.

"I remember," I react. "I saw the ring around the sun. It was sparkling like a diamond ring."

"We could see it just for a few seconds, when the sun was totally eclipsed. A scientist explained the phenomenon. There is no diamond ring around the sun. It is only an illusion created by the sunlight dancing over the uneven surface of the moon," Shalu adds.

Shadow Play

A night owl flies across. Its shadow is cast by the street lights. Uncle watches the racing shadows. We find two shadows of the owl as it covers the common ground between two street lights. The shadows are not of equal size. One is huge, but not very dark. The other one is small, but dark. Yet their sizes change every second, as the owl darts around. Then they are gone. Gone is the owl too.

"That is real shadow play," Uncle changes the topic quickly and says, "We have been out for more than an hour. Let us go back. It may be time for you to go to bed."

"No way. Tonight, you are going to make shadows play for us." Shalu hints at what she has in mind.

"Your Mamma will tuck both of you in bed the moment we reach home," Uncle teases.

It is nearly half past nine when we get back home. "You were out for long. It is time for the children to go to bed," Mamma says.

"Tomorrow is Sunday. We don't have school, Mamma. Let us spend some more time with Uncle. He does not come everyday," Shalu and I plead.

Uncle says, "I want to teach them how to play with shadows. Remember, we used to make the hare run on the wall?" Uncle reminds Mamma of their childhood days.

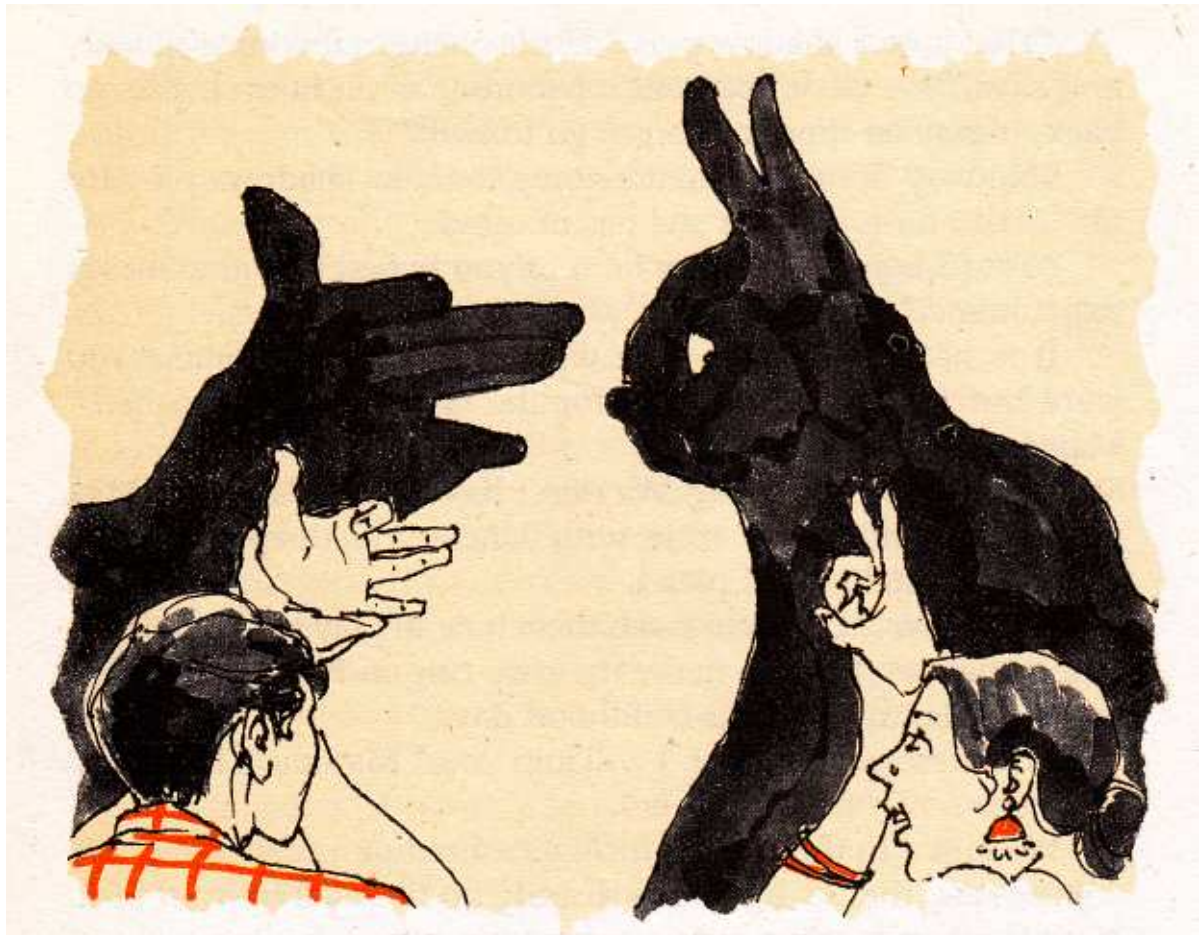
"We were good at that. I will join you," Mamma's face glow with joy.

We move to the study. Uncle gets hold of a table lamp. He adjusts it so that its light falls directly on the wall in front of it. "Out with all other lights," he tells me. I switch off the fluorescent lamp.

Mamma sits on the sofa. Shalu and I sit on either side of her. Uncle moves across the table lamp. His shadow falls on the wall. He moves back, brings his palms together, moves them on level with his eyes. He holds the thumbs up, adjusts them so that one thumb is slightly behind the other. He drops the little fingers, keeping them together. After some minor adjustment, Uncle settles down. We see the shadow of the face of a dog. Uncle wiggles the thumbs. The shadow dog wiggles its ears.

Mamma gets up and joins Uncle. "You have the dog. I shall produce a shadow hare," she says.

"My shadow dog will chase your shadow hare," Uncle jokes.



"Watch the chase," Mamma starts adjusting the fingers of her hands. She holds out her right hand, the back of the palm in front of her chest. She raises the first two fingers up. The thumb goes in to touch the last two fingers. Mamma now moves the hand, across the light. We see the shadow. It resembles a hare's head, with two ears sticking out.

Mamma starts shaping the fingers of her left hand. She bends the first two fingers, while the last two fingers press together and move up. The thumb stays apart. The last two fingers of the left hand slip in through the space, bounded by the thumb and the last two fingers of the right hand. The bent fingers of the left hand help shape the forelegs of the shadow hare. The

left thumb casts a shadow line of the hare's hind legs. The shadow hare is sitting on its hind legs.

Mamma moves the little finger of the right hand. We see the shadow hare moving its lips, nibbling at something. Shalu and I clap our hands. "Will the chase begin now?" we ask.

"No way, Your uncle has only produced the face of a shadow dog. How can the shadow dog run, when it has no body or legs?" Mamma jokes.

"Want to see?" Uncle moves his hands and makes the face run toward the hare. Mamma is equally quick with her shadow hare. The chase does not last long. Soon, the shadows lose their clarity.

"Well, we can't show you more of the chase. For that we need more space, more powerful lights. But you now know how to create shadow animals. All that you need are deft fingers and a bright light and a wall. You can try out various combinations of finger placements and lights to get other shadow figures... the shadow of a deer; or of a bird in flight," Uncle pauses.

"Show us how you make the shadow of a bird in flight." I urge Uncle.

He holds the thumbs together, spreads out the fingers of both hands so that they stand at right angles to the line of the thumbs. He holds his body, except for the palms, out of the range of the light and adjusts the palms. Then we see the shadow on the wall. It is of a bird, its wings fully spread out. Uncle moves the fingers on either side of the thumbs, together. We see the shadow of the bird in flight. Suddenly, Uncle stops the movements. He tilts the right hand up and dips the left hand down. Now the shadow of the bird stands at an angle. It is life-like.

"You can't create the shadow of a woodpecker, drilling holes in a tree," Shalu challenges Uncle.



"Don't be so sure, my girl," Uncle fixes Shalu with an icy stare. He looks all around. His eyes zero in on a cylindrical vase, which holds a few pens and pencils. Uncle empties out the contents of the table. He places the vase on a stool and shifts it around till the cup is in line with the light. The shadow falls on the wall. It resembles a trunk.

Uncle picks up a long pencil. He holds it between the fingers and the thumb. The fingers curve down to touch the thumb. Uncle pushes the pencil till it touches the vase. Then we see the head of the bird on the wall. The bird is resting on the trunk. The shadow of the pencil become the sharp tongue with which the woodpecker drills holes in a tree. "There you have it, Shalu," Uncle looks for our response.

"That was great," Shalu and I clap our hands.

"Thank you. Thank you for the applause," Uncle drops the

pencil back into the vase and shifts the vase and the stool aside. Then he adds, "We can paint the walls with shadows of animals and birds at will., They are ours to command," Uncle's face glows with joy.

Shadows on Screen

Mamma notices that and groans, "Part of the credit belongs to me, Hari ." Then she adds, "Want some more applause?"

"Who does not like applause?" Uncle takes a deep breath.

"Then join me in the next act," says Mamma, turns to me and says, "Can you get hold of a while bed sheet and a roll of twine?"

I fetch them within minutes. Mamma makes a screen out of the sheet and the twine. The four ends of the sheets are firmly held by twine, tied to the bars of the windows. The bed sheet becomes the screen. The table lamp is behind the screen. So is Uncle. He asks us to watch the screen. We sit, on our haunches, eager to watch the show. Then a hare appears on the screen. It hops around.

At times it is huge; at times it becomes rather small. Uncle speaks to us, from behind the screen, "You know why? When I my hands are close to the light, the shadow figure looks big. When I move from the light and get closer to the screen, the shadow grows smaller in size. That is one thing about shadows. Their size is dependent on the distance of the obstacle from the source of light."

Mamma disappears, for a few minutes. She returns, some time later, with rod puppets. She joins Uncle. Papa trails behind her. "May I watch the show?" he asks.

"You will have to pay the price," Mamma jokes.

"What is the price?" he asks.

"You will take us all to a movie, tomorrow. And then host a dinner," Uncle quotes the price.

"The price you quote is steep," Papa mumbles.

"Take it or leave it," Uncle growls.

"Beggars can't be choosers," Papa sighs.

He walks over to Uncle. Uncle shoos him away. "Oh, no. You are a spectator. You sit with the children."

Papa comes and sits with us. Mamma and Uncle present the puppet play of the tale of the hare and the tortoise. The shadows on the screen look life-like. Mamma and Uncle take turns to speak out the words of the characters. It is real fun.

We clap our hands, when the show ends. "Now you can join us," Uncle says. We go over to the other side of the screen. Uncle shows us the puppets. He holds one of the puppets against the light. The shadow hare appears on the screen.

He then lifts up Shalu, holds her against the light. Her shadow appears on the screen. She waves her hands. The shadow too does that. She kicks her legs. The shadow is quick to copy the movement. Uncle tells me to go on the other side of the



screen. I do that and catch Shalu's shadow. It is now thumping its nose.

I run back to Uncle. He adds, "Sometimes, the spectators don't see the actors. The screen stands between them and the actors. The screen never goes up. Yet the play is enacted. The actors stay behind the screen. Lights cast their shadows on the screen. The audience watch the shadow play. Just as you watched when I cast Shalu's shadow on the screen."

"Is the show over?" Papa asks.

"Yes. When do we get the treat?" Uncle asks.

"Remind me tomorrow," Papa yawns, bids us good night and walks off.

Identification with Photographs of Shadows

Mamma tells us, "It is time for bed."

Uncle pleads with her. "I just need ten minutes more."

"Time for what?" Mamma stifles a yawn.

"To give you all some more information about shadows," Uncle pauses.

"Make it snappy," Mamma snaps.

"See," Uncle lifts the table lamp, waves it above the table. He asks me to hold a long pencil vertically up on the table. I do that. He moves the light. It is now right atop the pencil. The pencil casts no shadow. Uncle moves the light around. The shadow moves. He moves the light far to the left. The shadow of the pencil lies on the right.

"We know that," Shalu wonders why Uncle is going over information he has already given us.

"Listen. Have you heard of aerial photographs. They are taken from the sky, either from balloons, aircraft or satellites? The photographs are never taken at noon. Usually they are taken an hour before dusk or an hour after dawn. That is the time when the shadow is long. The photograph shows the

shadow of the object clearly. Then it becomes easy to identify the object," Uncle points out.

X-Rays

"Have you told them of X-ray plates? They record shadows. X-rays are a great help to doctors. Someone suffers a fall. His hand swells up. He screams in pain. Has he fractured his hand? Or has he only sprained his arm? Nobody knows. The man



goes to the doctor. The doctor arranges an X-ray. The X-ray leads the doctor to the correct diagnosis. The patient receives the right treatment," Mamma details the scene.

"X-rays are invisible. They are more powerful than light. Light cannot penetrate solid objects. X-rays can do that but not all solids. They pass easily through the skin and the flesh. But bones or some hard growths in the body are opaque. So X-rays cast shadows when they run into such obstacles. These shadows are caught on photographic film or plate," Uncle explains.

The Shadow World of Cinema

"Which film shall we see tomorrow?" Shalu rolls her eyes sleepily.

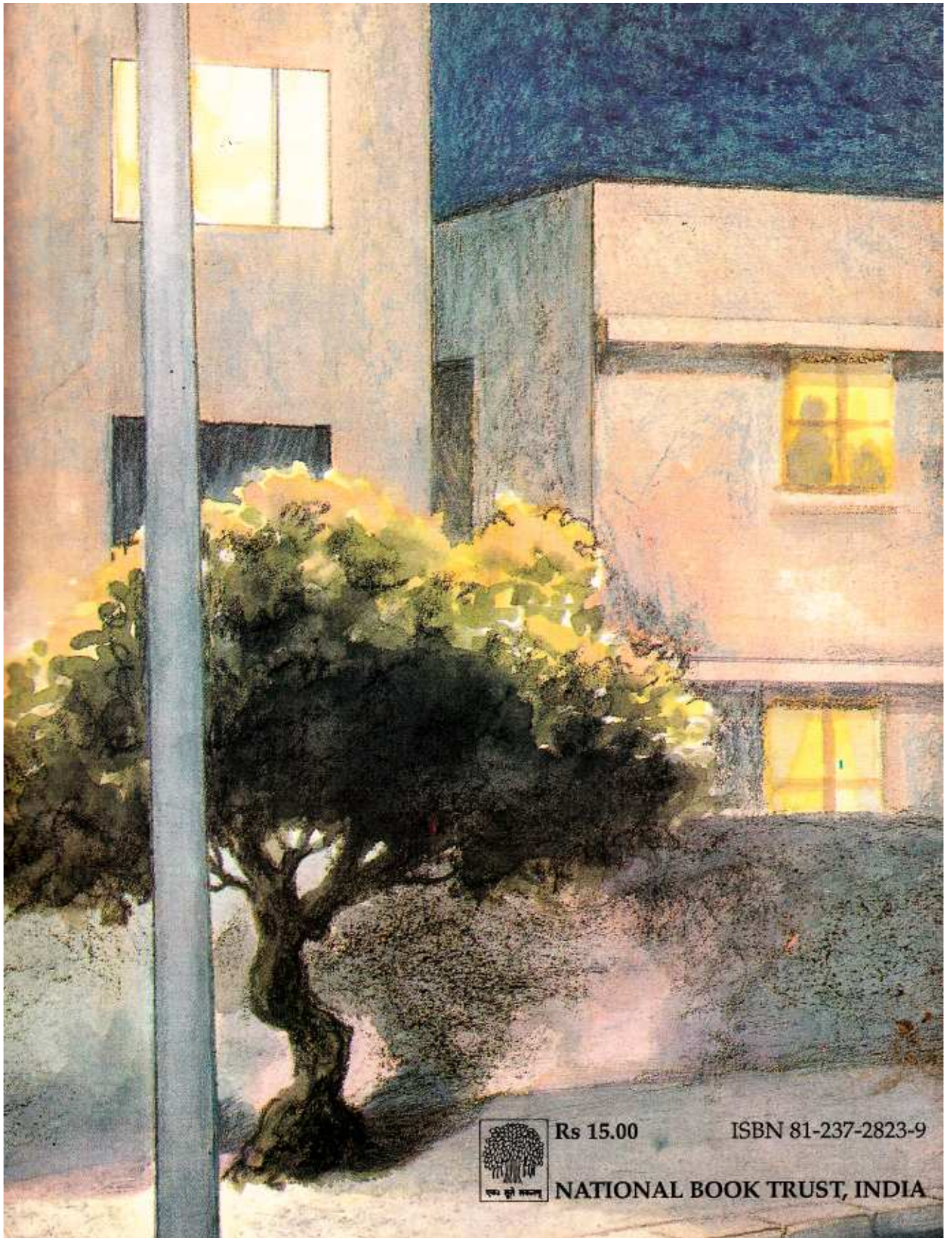
"Film? They too are shadows. The cinema is nothing but shadow play. Yet there is a difference. The scenes are filmed, in advance. The film is held against the lens, which is placed in the projector. The film unwinds. The lens magnifies the image, casts shadows on the screen." Uncle explains, but Shalu is already asleep on Mamma's lap.

"Shalu has gone into the shadow world of sleep. I think the shadows will scare her, unless I keep her company," I joke, hug Uncle and Mamma and run off to bed.





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